ENVIRONMENTAL ASSESSMENT

TERREBONNE BAY SHORE PROTECTION DEMONSTRATION PROJECT

Terrebonne Parish,
Louisiana

July 2003

U.S. Fish and Wildlife Service
Ecological Services
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

Phone: (337) 291-3100
Fax: (337) 291-3139

TABLE OF CONTENTS

FIGURES

TABLES

TERREBONNE BAY SHORE PROTECTION DEMONSTRATION PROJECT
Terrebonne Parish, Louisiana

SECTION 1.0 PURPOSE AND NEED FOR PROPOSED ACTION

The purpose of the proposed project is to demonstrate less-costly, effective alternatives to traditional rock rip-rap for protecting and restoring Louisiana's bay shorelines. Louisiana's interior bay shorelines are experiencing high rates of erosion and associated marsh loss. It is widely recognized that new, less-expensive erosion control techniques are needed for these areas. The project is funded through the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) as part of the 10th Priority Project List authorized on January 10, 2001.

SECTION 1.1 INTRODUCTION

The rapid conversion of Louisiana's coastal marshes and shorelines to open water has been reported by Gagliano et al. (1981), Gosselink (1984), Turner and Cahoon (1987), Britsch and Kemp (1990) and others. Coastal land loss in Louisiana has been reported to be from approximately 25 square miles per year (Dunbar et al. 1992) to 35 square miles per year (Barras et al. 1994). The rapid rate of loss of Louisiana's coastal wetlands is of particular concern; that loss represents 80 percent of the coastal wetland loss in the continental United States (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1998) and an estimated 69 percent of the coastal marshes adjacent to the Gulf of Mexico occur in Louisiana (West 1977). The loss of wetland acreage is accompanied by the loss of the various functions and values associated with wetlands, including: habitat for threatened and endangered species; water quality improvement; commercial harvests of fish, shellfish, furbearers and alligators; recreational fishing and hunting; protection of navigation corridors and port facilities; flood control, including buffering from hurricane storm surges; and ecotourism (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1998).

A number of factors, operating concurrently, are known to directly or indirectly contribute to the deterioration of Louisiana's coastal marshes. Those factors include sea level rise, subsidence, sediment deprivation, canalization, saltwater intrusion and altered hydrology (Turner and Cahoon 1987; Turner 1990). Those stressed ecosystems are very vulnerable to episodic damage and loss due to impacts from hurricanes and tropical storms. Although marsh loss rates have declined in some areas of coastal Louisiana, marsh loss rates have remained relatively high since the 1970s.

The Louisiana Coastal Zone includes nine hydrologic basins (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993*a*). The Terrebonne Basin extends from the Atchafalaya River eastward to Bayou Lafourche and experienced a greater loss of land than any other hydrologic basin in coastal Louisiana during the period 1932 to 1990 (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993*b*). That basin contains four subbasins. The southeastern portion of the Terrebonne Basin comprises the Timbalier Subbasin (Figure 1),

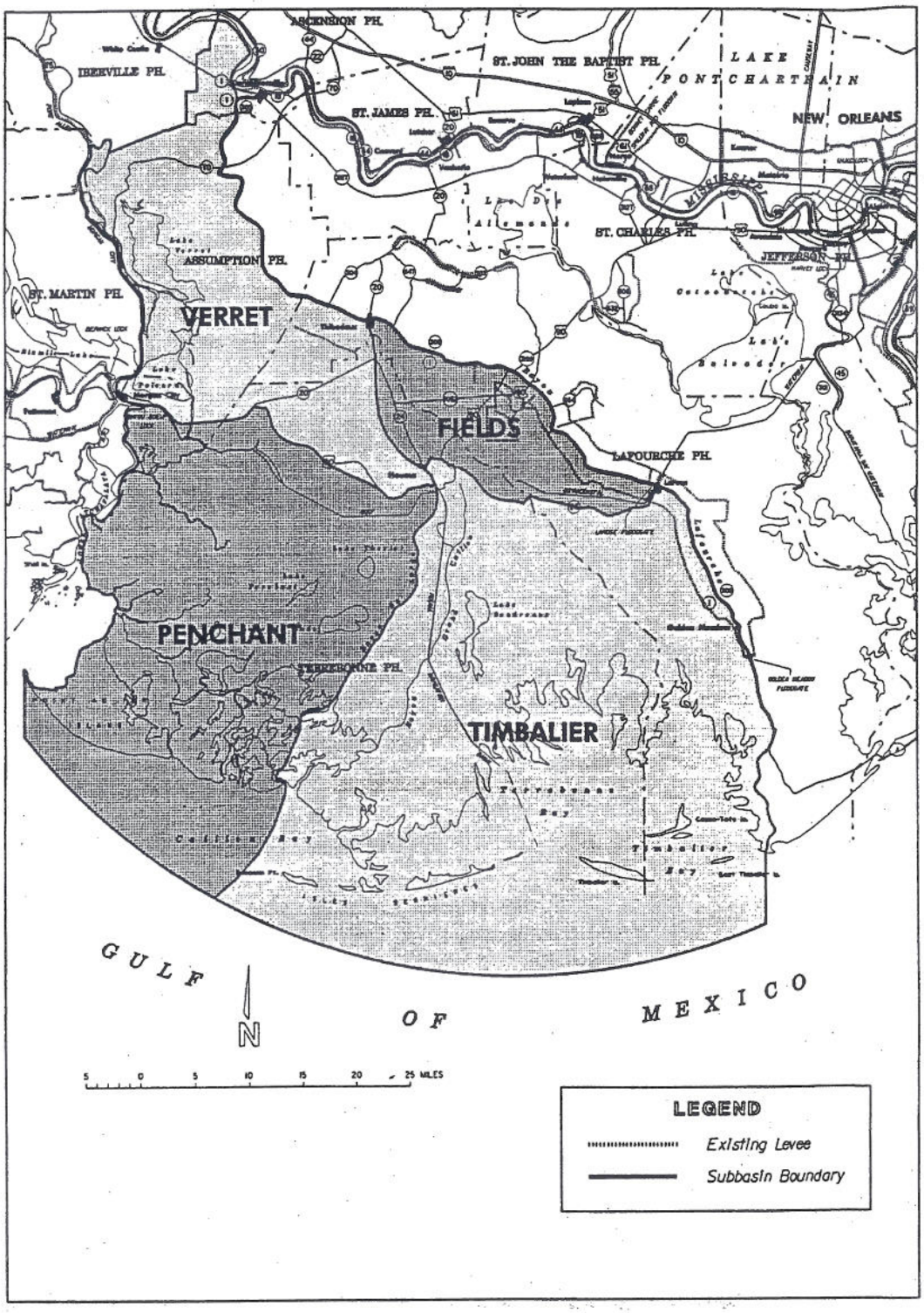


Figure 1. Map delineating the subbasins of the Terrebonne Basin.

in which the proposed project is located. Of the four subbasins, the Timbalier Subbasin has lost the most land (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993*b*).

The Timbalier Subbasin is characterized by a series of interdistributary basins isolated from each other by abandoned distributary channels. Land loss rates in this area vary, depending upon the specific interdistributary basin and the various factors affecting the basin. The northern portion of the Timbalier Subbasin once consisted of large tracts of fresh and intermediate marshes. Many of those marshes were of the floating ("flotant") type and vulnerable to deterioration via saltwater intrusion. The southern end of the basin is defined by a chain of narrow, low-lying barrier islands that mark the retreating edge of the old delta.

The project area is located north of Terrebonne Bay and east of Bayou Terrebonne along the shoreline of Lake Barre, in Terrebonne Parish, Louisiana (Figure 2). Due to marsh loss in the area, Lake Barre is no longer distinct from Terrebonne Bay and those marshes are now exposed to the physical forces of the larger bay complex. The remaining shoreline and marsh provides an important hydrologic and physical barrier between Terrebonne Bay and the lower salinity marshes to the north. The major causes of land loss in this area are subsidence and storm-induced wave erosion. The proposed project will evaluate several techniques which could be used to reduce the effects of wave erosion on the fragile marsh edge bordering Lake Barre and other areas in coastal Louisiana. Measures proposed for use in this project include artificial oyster reefs and other non-traditional shoreline protection techniques. Oyster reefs are known to dampen wave energy and thereby protect vulnerable marshes from erosion (Meyer et al. 1997). This Environmental Assessment evaluates alternatives for a demonstration project to evaluate the effectiveness of six different foreshore and onshore structures designed to reduce erosion and promote oyster reef building along shorelines in the Timbalier Subbasin. The preferred alternative is to demonstrate several less-costly structures which would restore and protect these rapidly eroding shorelines.

SECTION 1.2 NEED FOR PROPOSED ACTION

As noted above, rapid shoreline erosion is occurring throughout much of the Terrebonne Basin and other coastal Louisiana basins. Shoreline deterioration frequently results in accelerated erosion of both adjacent and interior wetlands. Loss of these wetlands is accompanied by the loss of the various values and functions associated with wetlands: habitat for a variety of wildlife, including threatened and endangered species, and recreationally and commercially harvested species; protection of navigation corridors and oil and gas facilities; buffering from storm surges; and water quality improvement. Maintenance of shoreline integrity along Terrebonne Bay is included in Regional Strategy Number 11 in the Coast 2050 plan (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998). Given the great length of shoreline involved in implementing this strategy, less costly alternatives to traditional rock rip-rap for shoreline protection must be developed and tested.

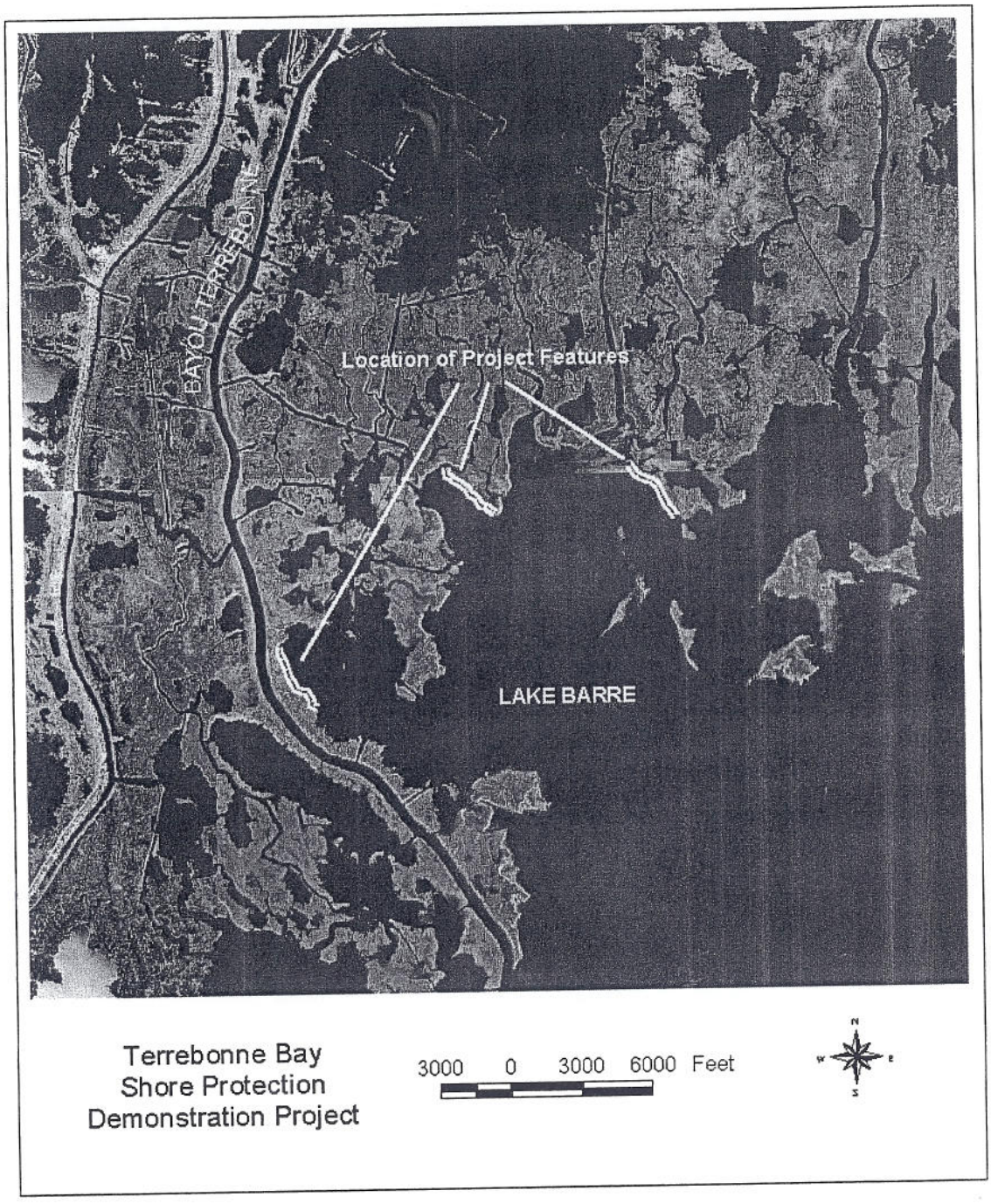


Figure 2. Map showing location of project features.

SECTION 1.3 PURPOSE OF PROPOSED ACTION

The purpose of the proposed project is to: 1) reduce shoreline erosion along a portion of Terrebonne Bay using a variety of non-traditional shoreline protection techniques; 2) quantify and compare the ability of each of the shoreline protection structures to reduce erosion and enhance oyster production; and, 3) quantify and compare the cost-effectiveness of each shoreline protection treatment in reducing shoreline erosion and enhancing oyster production. Those alternatives may be preferable to traditional limestone rip-rap because of cost and effectiveness, and may be applied in the future to protect more of Louisiana's bay and coastal lake shorelines which are experiencing severe erosion.

SECTION 1.4 REQUIRED DECISIONS

The project sponsor, i.e., the U.S. Fish and Wildlife Service (Service), will insure that the final decision on the preferred alternative is reached after a thorough public review and fully considering all comments received during that review.

SECTION 1.5 COORDINATION AND CONSULTATION

This project was coordinated with all of the Louisiana Coastal Wetlands Conservation and Restoration Task Force agencies, the Louisiana Department of Natural Resources (LDNR), the Louisiana Department of Wildlife and Fisheries, and local landowners. The project is supported because it is widely recognized that the bay shoreline is rapidly eroding and that new, less-expensive erosion control techniques are needed for these areas.

SECTION 2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

SECTION 2.1 SELECTION CRITERIA

Terrebonne Bay was initially selected for this demonstration project because of high local erosion rates and favorable conditions for oyster growth, and because the area is typical of much of the eroding lake and bay shorelines along the Louisiana coast. Measures proposed for use in this project include artificial oyster reefs and other shoreline protection techniques. The selected project area is located north of Terrebonne Bay and east of Bayou Terrebonne along the shores of Lake Barre, in Terrebonne Parish, Louisiana (Figure 2).

Five sites along the northern edge of Lake Barre were initially selected as potential locations for this demonstration project. Those sites were chosen for several reasons: 1) the general location was in an area where erosion rates were known to be high and where salinities are conducive for oyster reef development; 2) each location consisted of a continuous segment of relatively uniform shoreline of sufficient length to accommodate at least 300 feet of each treatment, along with a control; 3) the five locations were in close enough proximity to avoid unnecessarily high

mobilization costs associated with construction. A minimum of three sites would be selected in order to ensure a valid statistical design for treatment comparisons. Selection of the three sites was based on an evaluation using various site parameters such as location, adequate shoreline length (based on updated surveys), landowners, avoidance of potential damage to private oyster leases, utilities that could pose a problem during construction, and any anomalies that could potentially affect the rate of shoreline loss and pose a problem to the statistical analyses (Morris P. Hebert, Inc. 2002).

Eleven different shoreline protection and artificial oyster reef structures were evaluated by Morris P. Hebert, Inc., of Houma, Louisiana. Design criteria included geotechnical investigations to determine the stability and settlement characteristics of the soils supporting each structure type; surveys of marsh elevation and water depth; analysis of mean low and mean high water elevations; and analysis of wind speed and direction. All project features were also required to be constructed using shallow draft equipment. In order to avoid negative impacts on existing oyster leases near the project area, flotation channels and propwashing for construction access were to be prohibited for this project. The shallow water and presence of oyster leases is typical of the bay shorelines in Louisiana, and avoidance of negative impacts to those leases is an important consideration for larger-scale implementation of any shoreline protection features. The six structures in the preferred alternative were selected based on construction and installation methodology, potential impacts to existing oyster leases, cost, and ease of removal after the demonstration period (Morris P. Hebert, Inc. 2002).

SECTION 2.2 ALTERNATIVE 1 - NO ACTION

Under this alternative, no action would be taken to reduce erosion or to demonstrate and statistically evaluate alternative structures to prevent erosion and restore shorelines along Terrebonne Bay in Terrebonne Parish, Louisiana.

SECTION 2.3 ALTERNATIVE 2 - PREFERRED ALTERNATIVE

The preferred alternative will demonstrate the effectiveness of six separate shoreline protection techniques. Each of the proposed project features is designed to reduce the effects of wave energy on the shoreline and to provide a substrate for oyster reef development, utilizing natural processes of oyster settlement and growth to develop a living reef. Those reefs are expected to attenuate wave energy, potentially enhancing the effectiveness of the structures in reducing the rate of erosion and encouraging sedimentation and vegetative growth. Local soil, water level, and wave environments were evaluated and the recommended designs were analyzed to determine their likely integrity over a 20-year project life, although this project will only be monitored for 8 years. Each treatment will be constructed on each of three separate reaches of shoreline. Thus, each technique will be replicated three times, in order to allow statistically valid comparisons of the treatments. Reference sites (without protection) will also be monitored for comparison to the protected sites. Monitoring will include biological and engineering evaluations so that both the structural and biological effects of those techniques can be evaluated.

This alternative includes the following features (see Appendix A for detailed illustrations of the proposed structures):

1) Onshore Submar™ pre-cast articulated concrete mattresses.

2) Foreshore A-Jacks™, 2 feet high, with geotextile and 6 inches of crushed limestone as a base.

3) Foreshore Reef Balls™, 2.5-foot base, placed in three staggered rows.

4) Foreshore Reefblks™, 5 feet wide x 2 feet high, placed as recommended by Coastal Environments, Inc. (Gagliano 1997).

5) Foreshore Concrete Frame Structure, 5 feet wide x 10 feet long x 2.5 feet high.

6) Onshore Triton™ gabion mats filled with crushed stone.

SECTION 3.0 AFFECTED ENVIRONMENT

SECTION 3.1 PHYSICAL ENVIRONMENT

A. Physical Environment

The project area is located north of Terrebonne Bay and east of Bayou Terrebonne along the shores of Lake Barre, in Terrebonne Parish, Louisiana (Figure 2). Due to marsh loss in the area, Lake Barre is no longer distinct from Terrebonne Bay and those marshes are now exposed to the physical forces of the larger bay complex. The remaining shoreline and marsh provides an important hydrologic and physical barrier between Terrebonne Bay and the lower-salinity marshes to the north. The major causes of land loss in this area are subsidence and storm-induced wind and wave erosion.

Subsidence in the Terrebonne marshes is estimated to be 2.1 to 3.5 feet per century (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998). The Terrebonne Bay system is currently isolated from direct river inflows (Huh and Rouse 1994). Thus, the high subsidence rate is not off-set by riverine sediment input and retention. Sediment input into project area marshes comes largely in the form of suspended sediment being trapped in the vegetation along the marsh edge during high-water events. The source of the suspended sediment is largely re-suspension of bay-bottom sediments and sediment associated with the deteriorating marshes north of the bay. Background suspended sediment concentration in Lake Barre is approximately 10 mg/liter but can be as high as 1000 mg/liter during post-frontal northerly winds (Adams et al. 1994). From April to October, winds are light and sediment transport is minimal. From November to March, frontal passages drive

currents that are capable of transporting large amounts of suspended sediment. Southerly winds preceding frontal passage can transport suspended sediments from the bay to the marsh (Adams et al. 1994).

A significant amount of the land loss in the area may be attributed to wind and wave erosion of shorelines (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998). The proposed project sites exhibit the typical characteristics of lake rim natural levee, where the highest elevation of marsh is adjacent to the water's edge and the marsh elevation slopes downward away from the bay. The average shoreline erosion rate for the three selected shoreline reaches during the period from 1932 to 1983 was about 5 feet per year (Todd Folse, LDNR, personal communication). This long-term average may not reflect current loss rates; analysis of aerial photography taken in 1998 and 2001 revealed a retreat of 50 to 75 feet for marsh-dominated shoreline during that time period in parts of the project area (Brian Kendrick, Morris P. Hebert, Inc., personal communication). Visible signs of erosion are evident along the shoreline.

Project-area soils are characterized as saltwater marsh, clays and mucky clays (Sa). They consist of alluvial sediments deposited by distributary streams of the Mississippi River and reworked by waves and tides. Soils are typical of the shores of bays and lakes found along the Gulf of Mexico. Those soils occur at near-Gulf levels and are frequently flooded with salt water by a few inches during normal tides and can be flooded by up to 2 feet of water during strong southerly winds. Geotechnical borings conducted for this project indicate that the surface soils consist of 3 to 8 feet of very soft humus (peat) (Morris P. Hebert, Inc. 2002). The bearing capacity of this surface layer is very low, and most structures cannot be supported without an additional base platform to dissipate the load.

B. Water Quality

Salinity in Lake Barre varies with precipitation, tides, Atchafalaya River stage, and wind direction. The Louisiana Department of Wildlife and Fisheries (LDWF) has measured salinity in Lake Barre as part of its finfish sampling program consistently since 1981. Based on those data, which were collected at least monthly and often several times per month from March 1981 to May 2000, salinity in Lake Barre ranged from 3.4 parts per thousand (ppt) to 29.3 ppt with a mean salinity of 16.6 ppt. Those salinities are conducive to oyster production and much of the lake bottom is leased for that purpose.

The Louisiana Department of Environmental Quality (LDEQ) conducts water quality assessments of surface waters throughout the state. The LDEQ has assessed individual water bodies for the following uses: primary contact recreation (swimming), secondary contact recreation (boating and fishing), fish and wildlife propagation, and shellfishing. Water quality in a particular waterbody segment is determined to either fully, partially, or not support these uses. Water quality in the project area was not assessed for most uses but was found not to support shellfishing, due largely to the potential presence of pathogens indicated by the presence of fecal

coliform bacteria. The Louisiana Department of Health and Hospitals sets seasonal oyster harvest closure zones, based largely on fecal coliform data. Those zones may vary throughout the year, depending on environmental conditions. The project-area waters were included in the closed zone for approximately half of the year during 2001 (Figure 3).

SECTION 3.2 BIOLOGICAL ENVIRONMENT

A. Vegetation

Project-area marshes have been classified as saline marsh since at least 1949 (O'Neil 1949). Although much of the marsh acreage has been lost since that time, saline marshes are still dominant in the project area. Currently, the eroding saline marsh shoreline consists primarily of saltmarsh cordgrass. Other species commonly found in these salt marshes include needlegrass, seashore saltgrass and saltwort.

B. Fish and Wildlife Resources

Coastal marshes provide foraging habitat for wading birds such little blue heron, great blue heron, yellow-crowned night heron, black-crowned night heron, great egret, snowy egret, white-faced ibis and white ibis; shorebirds such as black-necked stilt; wintering dabbling and diving ducks such as gadwall, American widgeon, lesser scaup, canvasback, redhead, ring-necked duck, redbreasted merganser, common merganser and hooded merganser; and other marsh birds such as rails, coots and galinules. Low densities of furbearers such as nutria, muskrats, river otters and raccoons may be found in the project-area marshes.

The marshes and associated shallow waters adjacent to Terrebonne Bay support many recreationally and commercially important fishes and shellfishes such as, red drum, black drum, sand seatrout, spotted seatrout, Atlantic croaker, spot, sheepshead, southern flounder, Gulf menhaden, blue crab, white shrimp and brown shrimp. The American oyster is harvested commercially within the project area.

C. Oysters

Louisiana has a very productive oyster fishery and often leads the nation in commercial oyster production. This high productivity is largely due to the State's extensive estuarine wetland and shallow water habitats and the ability of the oyster, and the fishery it supports, to adapt to changing environmental conditions. Salinity is considered the most important driving force in the distribution and survival of oysters (Chatry et al. 1983). Melancon et al. (1998) delineated zones of oyster distribution in the Barataria and Terrebonne estuaries, based on salinity. The sites chosen for this demonstration project are located within the wet-dry zone where oysters can be found during both excess rain cycles and drought cycles. During extreme drought years and the resulting higher salinities, however, the oyster drill (a significant oyster predator) has been found in the project area (personal communication, Earl Melancon).

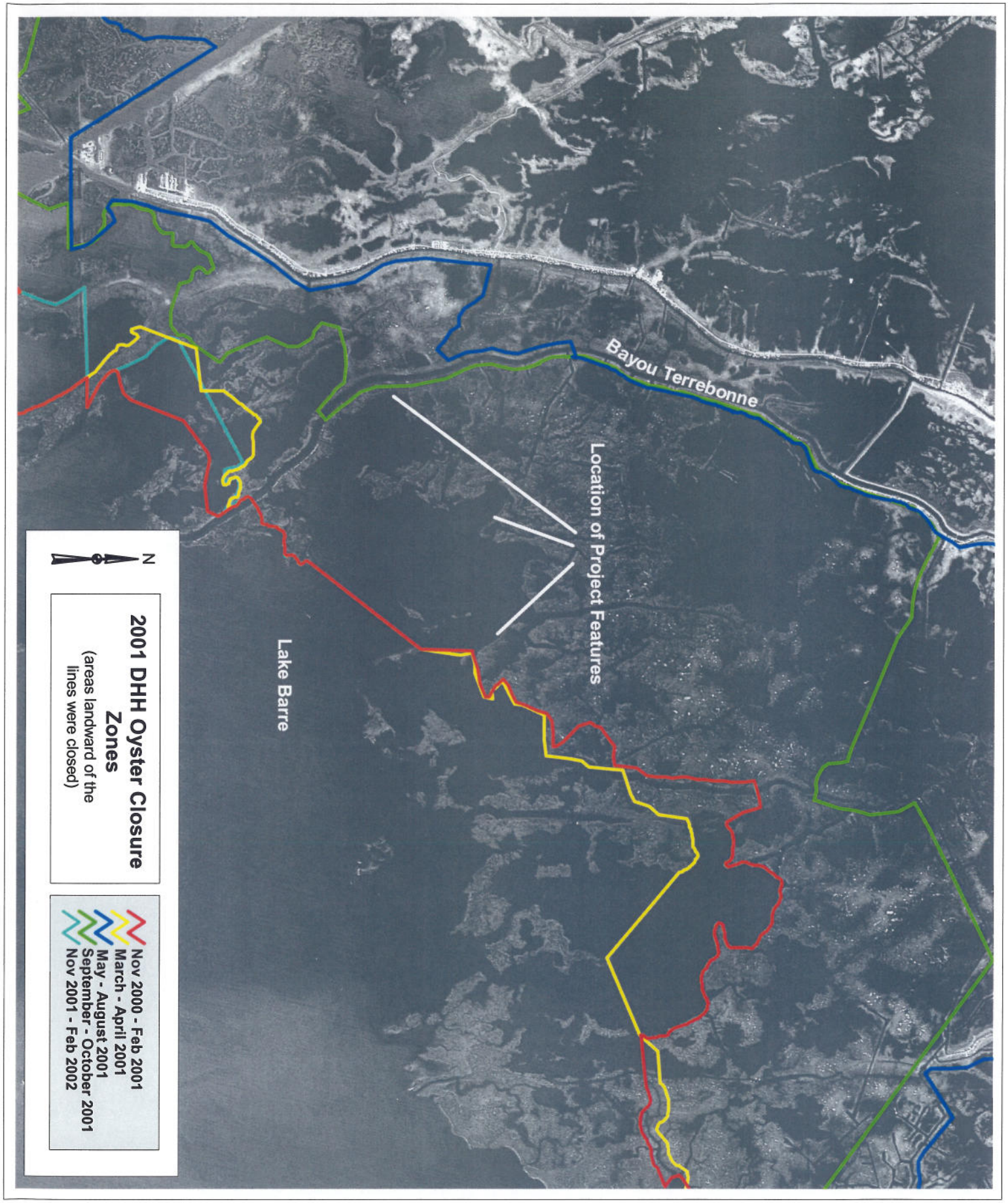


Figure 3. Map delineating oyster harvest closure zones for Nov 2000 - Feb 2002.

Oyster reefs play an important ecological role in the estuary. Oysters provide essential ecological services such as: filtering water, thereby controlling eutrophication (Gottleib et al. 1996); providing structure that serves as essential habitat for many invertebrates and fishes, which in turn helps to govern the food web (Zimmerman et al. 1989; Coen et al. 1999); aiding in nutrient cycling (Dame 1999); and offering protection to marsh wetlands as a buffer to wave activity (Gagliano et al. 1997; Meyer et al. 1997). Both intertidal and subtidal oyster reefs support a larger assemblage of fish than do either nearby sand or mud bottom (Lehnert and Allen 2002).

The majority of oysters fished commercially in Louisiana are subtidal, although a significant intertidal population does exist. In recent years more attention has been focused on intertidal and shallow subtidal oyster reefs and their ecological role (Bahr and Lanier 1981; Meyer and Townsend 2000). Physical factors such as tidal height and substrate level are critical components of intertidal oyster survival and reef building (Bartol et al. 1999). Habitat structure and shape may also influence oyster spat setting and survival (Lenihan 1999). Intertidal oysters are commonly found in the marsh in the project area, suggesting that this area is suitable for the proposed oyster reef structures.

D. Essential Fish Habitat

The proposed project is located in an area identified as Essential Fish Habitat (EFH) for postlarval, juvenile, and sub-adult life stages of white shrimp and brown shrimp; larval, postlarval, juvenile, and sub-adult red drum; postlarval and juvenile gray snapper; juvenile Spanish mackerel (Table 1). EFH requirements vary depending upon species and life stage. Categories of EFH in the project area include estuarine emergent wetlands, estuarine water column, and estuarine mud and shell substrates. Detailed information on Federally managed fisheries and their EFH is provided in the 1998 generic amendment of the Fishery Management Plans for the Gulf of Mexico prepared by the Gulf of Mexico Fishery Management Council (GMFMC). The generic amendment was prepared in compliance with the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (P.L. 104-297).

In addition to being designated EFH for white shrimp, brown shrimp, red drum, gray snapper, and Spanish mackerel, estuarine aquatic habitats that may be affected by the project provide nursery and foraging sites for a variety of economically important fishery species including Atlantic croaker, spotted seatrout, sand seatrout, striped mullet, Gulf menhaden, southern flounder, spot, and blue crab. Some of those estuarine-dependent species serve as prey for other species managed under the MSFCMA by the GMFMC (e.g., red drum, mackerels, snappers and groupers) and highly migratory species managed by the National Marine Fisheries Service (e.g., billfishes and sharks).

Table 1. EFH requirements for Federally managed species that occur in the project area.

Species	Life Stage	EFH in Project Area*
brown shrimp	postlarvae/juvenile	E, marsh edge, marsh ponds, inner marsh, oyster reefs
	subadults	E, mud bottom, marsh edge
white shrimp	postlarvae/juvenile	E, marsh edge, marsh ponds, inner marsh, oyster reefs
	subadults	E, marsh edge, marsh ponds, inner marsh, oyster reefs
red drum	larvae	M, planktonic
	postlarvae/juvenile	E, mud bottoms, marsh/water interface
	subadults	E, mud bottoms, oyster reefs
gray snapper	postlarvae/juvenile	E, mud bottoms
Spanish mackerel	juvenile	M/E beach, estuarine water column

* (E = estuarine, M = marine)

E. Threatened and Endangered Species

Project-area marshes and associated shallow estuarine waters provide foraging habitat for both bald eagles and brown pelicans. The bald eagle is currently listed as a threatened species, but has been proposed for removal from the Federal list of threatened and endangered species. The Endangered brown pelican may occasionally be observed foraging in the area during the winter. There are no known nesting sites for either species near the project.

SECTION 3.3 CULTURAL AND RECREATIONAL RESOURCES

Various cultural resources occur throughout the Louisiana coastal zone, including both prehistoric and historic sites. The Louisiana Department of Culture, Recreation and Tourism maintains catalogues of numerous cultural resource sites, but many areas remain unsurveyed and the significance or eligibility of some sites for inclusion in the National Register of Historic Places has not been determined. A May 17, 2002, review by the Louisiana Office of Cultural Development, Division of Archeology, revealed no known cultural or archeological sites in the project area.

Recreational use of the project area is oriented primarily toward hunting and fishing. Boats are needed to access all project-area marshes and associated fishing areas.

SECTION 3.4 ECONOMIC RESOURCES

The interior marshes near the project area contain several oil and gas facilities and pipelines. Oil and gas production is a large part of the local economy. The marshes north of Terrebonne Bay provide some protection of these facilities from storm-associated wind and wave energy.

Coastal wetlands like those within the project area help to support commercially and recreationally important fishes and shellfishes such as red drum, blue crab, white shrimp and the American oyster. The total economic value of Louisiana fisheries landing are believed to exceed $1 billion annually. Louisiana's shrimp harvest comprises approximately 35 to 40 percent of the national shrimp harvest, and Louisiana often produces as much as one-third of the U.S. supply of oysters (source: National Marine Fisheries Service). In addition, the abundant natural resources associated with Louisiana's coastal wetlands, and the unique local culture adapted to those wetlands, have helped to produce a growing tourism industry. Recreational use of the area provides business for private boat launches and sport-fishing charters.

SECTION 4.0 ENVIRONMENTAL CONSEQUENCES

SECTION 4.1 ALTERNATIVE 1 - NO ACTION

A. Physical Environment

Under this scenario, shoreline erosion in the project area along the northern edge of Lake Barre would continue at the current rate and no new shoreline protection techniques would be demonstrated and evaluated. Without effective, lower-cost alternatives to traditional rock rip-rap, large sections of shoreline are likely to remain unprotected in the future. Subsidence would continue at a relatively high rate. Loss of shoreline function would make the interior subsiding marshes even more susceptible to wave erosion and related loss.

B. Biological Environment

Vegetation, Fisheries and Wildlife
Wave erosion would continue along the shorelines of Terrebonne Bay; consequently, the present marsh shoreline would continue to retreat to the north. At the conservative estimate of 5 feet of erosion per year along the 6,000-foot project area, 5.6 acres of emergent marsh are expected to be lost over the 8-year project life. At the greater rate of 50 to 75 feet of erosion per year estimated for the period between 1998 and 2001, between 55.2 and 82.4 acres could be lost. As the emergent marsh was lost and replaced by open water, the value of that area as foraging habitat for wading birds, waterfowl, shorebirds and sea birds would decrease.

The continued conversion of emergent marsh to shallow open water may increase the foraging area for predatory saltwater fishes. Those fishes utilize the marsh edge habitat, which may initially increase. Over time, the habitat would become less suitable for these species as the amount of open water increased relative to the amount of emergent wetlands.

Oysters

The acreage of open water and shallow water bottoms available to be leased for oyster production may increase initially as the marsh erodes. Long-term oyster productivity would, however, decline as the marsh was lost. Some of the most productive leases near the project area are located in the small natural bayous that drain into Lake Barre from the north. The lake rim protects those bayous and associated productive leases from the erosive forces of the bay.

Essential Fish Habitat

Categories of EFH in the project area include estuarine emergent wetlands, estuarine water column and estuarine mud, sand, and shell substrates. Under the no action alternative, shoreline erosion and subsidence would continue to result in the loss of emergent wetlands in the project-area. Such loss would begin replacing estuarine emergent wetland with estuarine water column and mud and shell substrate. During fragmentation, increased marsh edge habitat could provide short term maintenance of managed fishery species (e.g. post larval/juvenile and subadult brown shrimp and white shrimp, and post larval/juvenile red drum). Long-term trends of those managed species/life stages, however, may begin declining with larger-scale conversion of estuarine emergent wetlands to estuarine open water, while other managed species/life stages (e.g. subadult and adult red drum, juvenile gray snapper, and juvenile Spanish mackerel) may increase. Thus, this alternative is expected to have long-term negative impacts to post larval/juvenile and subadult brown shrimp and white shrimp, and post larval/juvenile red drum. Over the long term, the no-action alternative may have minor positive impacts to subadult red drum, juvenile gray snapper and juvenile Spanish mackerel.

Threatened and Endangered Species

Project-area marshes and associated shallow estuarine waters provide foraging habitat for both bald eagles and brown pelicans. Under this alternative, the continued loss of marsh would reduce the value of the area as foraging habitat for those species.

C. Cultural and Recreational Resources

Continued marsh loss and subsequent reduction in fish and wildlife populations would likely result in a modest decrease in recreational use, especially saltwater fishing. Because of the saline nature of the project-area marshes, hunting use of the wetlands is not expected to be extensive; therefore, the effects of the no-action alternative on hunting participation is not likely to be substantial.

D. Economic Resources

Recreational and commercial fishing are important components of the local economy. Continued wetland loss would reduce fishing success, ultimately resulting in adverse economic impacts. The remaining oil and gas facilities may require costly additional protection and upgrading as marsh areas convert to open water. Storm-related impacts to those facilities could increase with a reduction in the storm buffering capacity of the adjacent wetlands.

SECTION 4.2 ALTERNATIVE 2 - PREFERRED ALTERNATIVE

A. Physical Environment

Under this scenario, approximately 6,000 feet of the Lake Barre shoreline will be protected by the shoreline protection structures. Shoreline erosion is expected to be reduced to some degree by those structures. The amount of reduction in erosion rate associated with each structure is currently unknown. It is expected that the various structures will have differing degrees of success in reducing erosion. This will be measured as part of the monitoring program and will be compared to the erosion rate at the unprotected reference sites. The structures may also promote deposition of the large amounts of suspended sediment available in Lake Barre. Maintenance of the lake rim will protect the marshes to the interior from the erosive forces of wind and waves, although the interior loss due to subsidence will not be directly impacted by the project. Potentially, one or more cost-effective shoreline protection techniques will be identified which may be used in the future to protect longer reaches of shoreline.

There may be temporary increases in turbidity associated with the construction of project features. The effect of that increased turbidity is expected to be minimal, given the large amounts of naturally occurring suspended sediments found in the bay. No flotation channels will be excavated and shallow draft vessels will be used for all construction activities, minimizing the negative construction-associated impacts. The potential adverse affect on water quality will be temporary, having little to no impact on emergent marsh or other biological resources.

B. Biological Environment

Vegetation
The preferred alternative would decrease the erosion rate along approximately 6,000 feet of Lake Barre, protecting the marsh vegetation along the shore. Accumulation of sediment and organic matter behind the proposed structures would further reduce erosion and may increase the amount of emergent vegetation coverage. Two of the proposed project features (articulated concrete mattresses and rock-filled gabion mats) will be placed partially on the emergent marsh vegetation and will extend out onto the water bottom. A total of 1/4 acre of marsh is expected to be covered by these two treatments. Without the project, between 5.6 and 82.4 acres of emergent marsh are expected to be lost over the 8-year project life. The project is expected to reduce this loss rate, resulting in a net positive impact on emergent marsh vegetation.

Fisheries and Wildlife
With the preferred alternative, the emergent marshes which support an abundance and diversity of fish and wildlife will decline less rapidly. Foraging habitat for the area's wading birds, shorebirds, sea birds, and waterfowl will be protected. The important marsh-edge habitat utilized by recreationally and commercially important fishes and shellfishes will decline at a slower rate. New techniques will be tested that could be used in the future to protect larger sections of bay and lake shorelines, thus increasing the likelihood that these important wildlife habitats will be maintained in the future.

Oysters
Project features will cover approximately 1.41 acres of bay mud bottom where some oysters may currently be found. The structures associated with the preferred alternative, however, are designed to encourage the creation of intertidal and subtidal oyster reefs. Those reefs are expected to have greater oyster productivity than the naturally occurring bottom-growing oysters, due to increased surface area available for oyster spat attachment. Those structures will also provide vertical substrate so that the oysters would be less likely to be impacted by natural sedimentation of the bay bottom. Creating artificial, productive intertidal reefs may have a positive effect on the commercially harvested subtidal oyster leases near the project area (e.g., by enhancing oyster spawning success). Maintaining the marsh shoreline will benefit oyster production. The various structures used to create artificial oyster reefs will be compared and evaluated. Some of those techniques may be used in the future to further enhance oyster productivity.

Essential Fish Habitat
Categories of EFH in the project area include estuarine emergent wetlands, estuarine water column and estuarine mud, sand, and shell substrates. Under the preferred alternative, shoreline erosion would be reduced, resulting in the maintenance of emergent wetlands. Creation of artificial oyster reefs will increase the amount of shell substrate. Therefore, that alternative will would positively impact post larval/juvenile and subadult brown shrimp, white shrimp, and red drum. Placement of project features will result in the loss of 1.41 acres of mud bottom, having a slight negative impact on postlarval/juvenile gray snapper and juvenile Spanish mackerel. On balance, however, the Service believes that the preferred alternative will have a positive impact on EFH for Federally managed species.

Threatened and Endangered Species
Project-area marshes and associated shallow estuarine waters provide foraging habitat for both bald eagles and brown pelicans. Maintenance of fish and shellfish habitat will help to preserve the project-area marshes for eagle and pelican foraging. Construction activities would temporarily make this area unavailable for foraging eagles and pelicans; however, there are currently other large areas available for foraging near the project area. The Service has determined that the project is not likely to adversely affect bald eagles or brown pelicans.

C. Cultural and Recreational Resources

There are no known archaeological sites in the project area. The State Historic Preservation Officer will be contacted, however, if any archeological material is uncovered during project implementation.

None of the project features will interfere with access to hunting and fishing areas. The structures and reefs themselves may become navigation hazards along the marsh edge and will be well marked to avoid any conflicts with boaters. Conversely, the structures are likely to attract several recreationally important fish species and may enhance fishing opportunities in the area. Maintenance of project-area marshes will help to maintain habitat for recreationally and commercially important species. Diverse habitats will be maintained, keeping the area a desirable destination for tourism activities.

D. Economic Resources

By reducing project-area wetland loss rates, this alternative would help to maintain that portion of the local economy dependent on recreational and commercial fish and wildlife resources. The upgrading of oil and gas exploration and production facilities would not need to be completed as soon. Storm-related impacts to those facilities may be reduced because of the storm-buffering capacity of the adjacent wetlands.

SECTION 5.0 RATIONALE FOR SELECTING THE PREFERRED ALTERNATIVE

The preferred alternative is supported by the Service because it would slow the rapid rate of erosion of the marsh shoreline and would test several new approaches to protecting highly erodible lake shores and adjacent coastal wetlands. These techniques may be used in the future by the Service or other entities to protect larger areas along bay shorelines. The project has received support from several natural resource agencies associated with the Louisiana Coastal Wetlands Conservation and Restoration Task Force.

SECTION 6.0 COMPATIBILITY WITH CWPPRA AND COMMUNITY OBJECTIVES

The preferred alternative would help to achieve CWPPRA-related objectives for protection and restoration of Louisiana's coastal wetlands. The techniques to be tested, if found to be cost-effective, may be incorporated into larger CWPPRA projects or other restoration projects in the future. The general public also supports wetland restoration and preservation for fish and wildlife habitat, for recreational, commercial, esthetic, and other non-consumptive uses.

SECTION 7.0 COMPLIANCE WITH LAWS, REGULATIONS AND POLICIES

This Environmental Assessment was prepared in accordance with the National Environmental Policy Act of 1969 (NEPA). It is consistent with the NEPA-compliance procedures contained in the Service's manual (550 FW 1-3), and employs a systematic, interdisciplinary approach. The proposed action involves disposal of fill material into waters; therefore, an evaluation under Section 404(b)(1) of the Clean Water Act of 1977, as amended, is required as well as state water quality certification under Section 401 of that Act. A Clean Water Act Section 404 permit has been received from the U.S. Army Corps of Engineers as well as Water Quality Certification from the Louisiana Department of Environmental Quality.

Under the MSFCMA, the Service has evaluated project-related impacts to essential fish habitat and initiated consultation with NOAA Fisheries upon submission of the draft Environmental Assessment. Although the preferred alternative would result in small adverse impacts to some categories (i.e., mud bottom) of EFH, more productive categories of EFH, such as oyster reefs and estuarine emergent wetlands, would be created and/or protected. Given the overall beneficial effects of the preferred alternative, the Service has determined that adverse impacts to some EFH that may result from project construction would be adequately offset by the benefits provided by the protection and creation of other habitats designated as EFH.

The proposed action is located within the Louisiana Coastal Zone, but involves no construction activities that would result in significant direct, indirect, or cumulative adverse impacts to coastal waters or wetlands. The Service has been granted a Consistency Determination from the Louisiana Coastal Resources Program (LCRP). By letter dated April 14, 2003, the Louisiana Department of Natural Resources indicated that the Preferred Alternative is consistent with the LCRP.

By letter dated May 17, 2002, from the State Historic Preservation Officer, no known archaeological sites or historic properties will be affected by the project. Therefore, the project is compliant with the National Historic Preservation Act of 1966, as amended.

Pursuant to Executive Order 12898 (Environmental Justice for Minority Populations), the Service has determined that the Preferred Alternative will not result in disproportionately high and adverse human health or environmental impacts on minority and low-income populations.

Other Federal and state issues reviewed for compliance for the proposed action include, but are not limited to, the Endangered Species Act of 1973, as amended; Archeological and Historic Preservation Act of 1974; Executive Order 11988 (Floodplain Management); Executive Order 11990 (Protection of Wetlands); Executive Order 13186 (Protection of Migratory Birds). Full compliance with relevant laws and regulations has been achieved with review of this Environmental Assessment by appropriate agencies and interested parties, and the signing of a Finding of No Significant Impact and Environmental Action Statement.

SECTION 8.0 PREPARER

This Environmental Assessment was prepared by the U.S. Fish and Wildlife Service, Ecological Services, Lafayette, Louisiana. The document was prepared primarily by Fish and Wildlife Biologist Martha Segura, who is the Project Manager.

SECTION 9.0 LITERATURE CITED

Adams, C.E., Jr, L. Xu, N.D. Walker, and S.P. Murray. 1994. Flow and sediment transport in Lake Barre, a shallow embayment in Terrebonne Bay, Louisiana. Pages 4.1.1-4.1.11 *in* H.H. Roberts (ed.), Critical Physical Processes of Wetland Loss, 1988-1994. Open-file report to the U.S. Geological Survey, Reston, Virginia.

Bahr, L.M., and W.P. Lanier. 1981. The ecology of intertidal oyster reefs of the South Atlantic: a community profile. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. , FWS/OBS-81-15. 105 pp.

Barras, J.S., P.E. Bourgeois, and L.R. Handley. 1994. Land loss in coastal Louisiana 1956-90. National Biological Survey, National Wetlands Research Center Open File Report 94-01.

Bartol, I.K., R. Mann, and M.W. Luckenbach. 1999. Growth and mortality of oysters (*Crassostrea virginica*) on constructed intertidal reefs: effects of tidal height and substrate level. Journal of Experimental Marine Biology and Ecology 237:157-184.

Britsch, L.D., and E.B. Kemp. 1990. Land loss rates: Mississippi River deltaic plain. U.S. Army Corps of Engineers, New Orleans, Louisiana, Tech. Rpt. GL-90-2.

Chatry, M., R. Dugas, and K.A. Easley. 1983. Optimum salinity regime for oyster production on Louisiana's state seed grounds. Contr. Mar. Sci. 26:81-94

Coen, L.D., M.W. Luckenback, D.L. Breitburg. 1999. The role of oyster reefs as essential fish habitat: a review of current knowledge and some new perspectives. Am. Fish. Soc. Symp. 22:438-454.

Dame, R.F. 1999. Oyster reefs as components in estuarine nutrient cycling: incidental or controlling? *In* Luckenbach, M.W., R. Mann and J.A. Wesson, eds. Oyster Reef Habitat Restoration: A Synopsis and Synthesis of Approaches. Proceedings from the Symposium. Williamsburg, VA.

Dunbar, J.B., L.D. Britsch, and E.B. Kemp, III. 1992. Land Loss Rates, Report 3, Louisiana Coastal Plain. Technical Report GL-90-2. Vicksburg, MS.: U.S. Army Corps of Engineers, U.S. Waterways Experiment Station.

Gagliano, M.H., S.M. Gagliano, and P.J. Moses. 1997. Bay Rambo Oyster Reef: An artificial oyster reef in the deltaic estuarine area of Louisiana. Coastal Environments, Inc. Baton Rouge, LA.

Gagliano, S.M., K.J. Meyer-Arendt, and K.M. Wicker. 1981. Land loss in the Mississippi River deltaic plain. Transactions of the Gulf Coast Association of Geological Societies 31:295-300.

Gosselink, J.G. 1984. The ecology of delta marshes of coastal Louisiana: A community profile. U.S. Fish and Wildlife Service FWS/OBS-84/09. U.S.A. 134 pp.

Gottleib, S.J., and M.E. Schwdeighofer. 1996. Oysters in the Chesapeake Bay ecosystem: a case for exotic species introduction to improve environmental quality? Estuaries 19:639-650.

Huh, O.K., and L.J. Rouse, Jr. 1994. Remote sensing of sediment despersal, p. 4.5.1-4.5.16 *in* H.H. Roberts, ed. Critical Physical Processes of Wetland Loss, 1988-1994. Open-file report to the U.S. Geological Survey, Reston, Virginia.

Lehnert, R.L., and D.M. Allen. 2002. Nekton use of subtidal oyster shell habitat in a southeastern U.S. estuary. Estuaries 25:1015-1024.

Lenihan, H.S. 1999. Physical-biological coupling on oyster reefs: how habitat structure influences individual performance. Ecol. Monogr. 69:251-275.

Louisiana Coastal Wetlands Conservation and Restoration Task Force. 1993*a*. Louisiana Coastal Wetlands Restoration Plan, Main Report and Environmental Impact Statement. 308 pp.

Louisiana Coastal Wetlands Conservation and Restoration Task Force. 1993*b*. Louisiana Coastal Wetlands Restoration Plan, Main Report and Environmental Impact Statement. Appendix E, Terrebonne Basin. 308 pp.

Louisiana Coastal Wetland Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority. 1998. Coast 2050: Toward a Sustainable Coastal Louisiana. Louisiana Department of Natural Resources. Baton Rouge, La. 161 pp.

Melancon, E.J., T.M. Soniat, V. Cheramie, M. Lagarde, R. Dugas, and J. Barras. 1998. Oyster resource zones of the Barataria and Terrebonne estuaries of Louisiana. J. Shellfish Res. 17:1143-1148.

Meyer, D.L., E.C. Townsend, and G.W. Thayer. 1997. Stabilization and erosion control value of oyster cultch for intertidal marsh. Restoration Ecology 5(1):93-99.

Meyer, D.L., and E.C. Townsend. 2000. Faunal utilization of created intertidal eastern oyster (*Crassostrea virginica*) reefs in the southeastern United States. Estuaries 23(1):34-45.

Morris P. Hebert, Inc. 2002. Terrebonne Bay Shore Protection Demonstration Project (TE-45) Feasibility and Preliminary Design Report. LDNR Contract No. 2503-00-28.

O'Neil, T. 1949. Map of the southern part of Louisiana showing vegetation types of the Louisiana marshes. *In* The Muskrat in the Louisiana Coastal Marshes. Louisiana Department of Wildlife and Fisheries, New Orleans, LA.

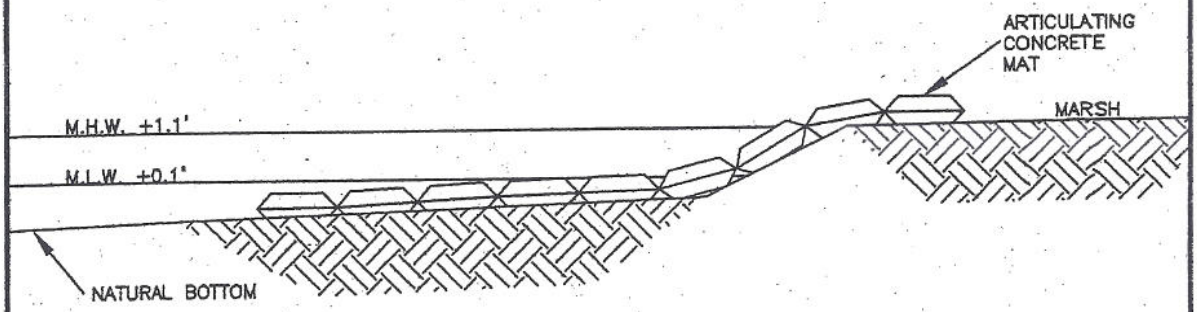
Turner, R.E., and D.R. Cahoon, eds. 1987. Causes of wetland loss in the coastal central Gulf of Mexico. Volume 1, Executive summary. Final Report submitted to Minerals Management Service, New Orleans, Louisiana. Contract Number 14-12-0001-30252. Outer Continental Shelf Study/MMS 87-0119. 32pp.

Turner, R.E. 1990. Landscape development and coastal wetland losses in the northern Gulf of Mexico. Amer. Zool. 30:89-105.

West, R.C. 1977. Tidal salt-marsh and mangal formations of Middle and South America. Pages 193-213 *in* Chapman, V.J., ed. Ecosystems of the World. I. Wet Coastal Ecosystems. Elsevier Scientific Publ., New York.

Zimmerman, R., Minello, T.J., Baumer T., and M. Castiglione. 1989. Oyster reef as habitat for estuarine macrofauna. NOAA Technical Memorandum NMFS-SEFC-249.

APPENDIX A - Detailed Illustrations of Project Features



PROFILE
NOT TO SCALE

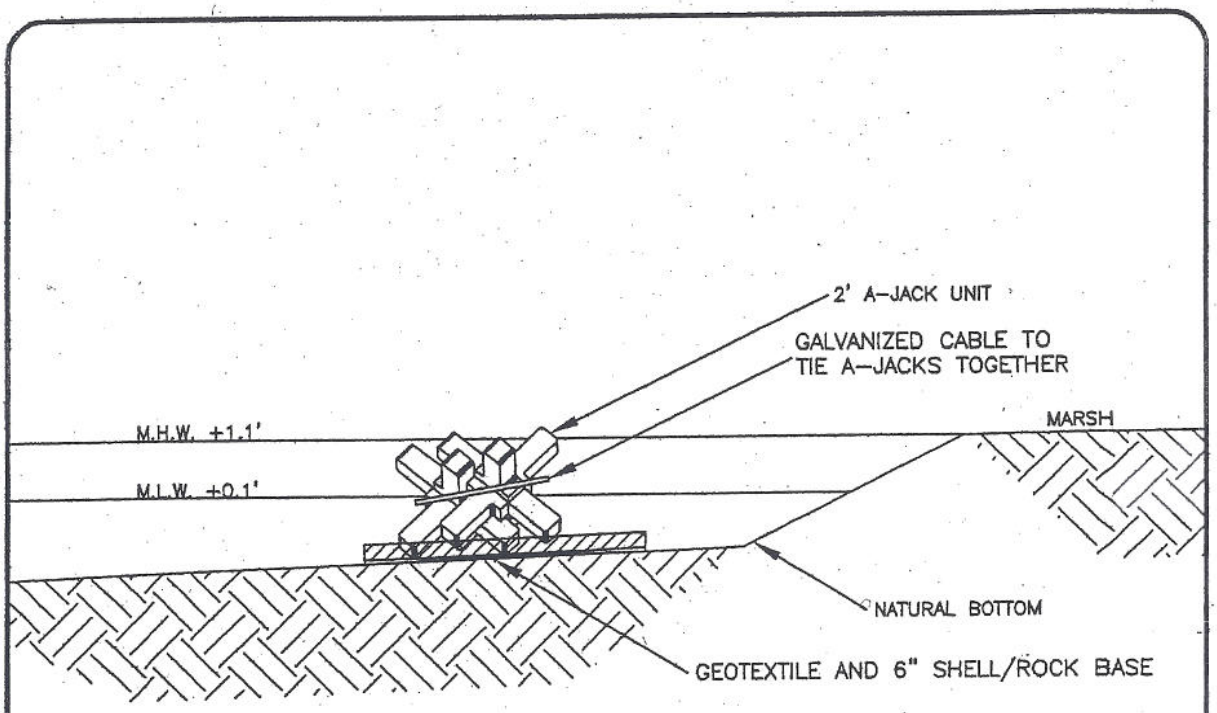
NO.	DATE	REVISION
1	11/27/02	INCORPORATED USFWS AND LDNR/CRD COMMENTS

USFWS AND LDNR/CRD

TYPICAL DETAIL OF ARTICULATING CONCRETE MAT
TERREBONNE BAY SHORE PROTECTION DEMONSTRATION PROJECT (TE-45)
TERREBONNE PARISH, LOUISIANA

mph Morris P. Hebert, Inc.
SURVEYING • ENGINEERING • ENVIRONMENTAL SERVICES
P.O. BOX 3106 • HOUMA, LOUISIANA 70361-3106 • (985) 879-2731

DRAWN BY:	TJF	SHEET:	8
CHECKED BY:	RCJ	SCALE:	N.T.S.
APPROVED BY:	DBK	DATE:	7/17/02
MPH CAD FILE:	6818COE0013A1		



PROFILE
NOT TO SCALE

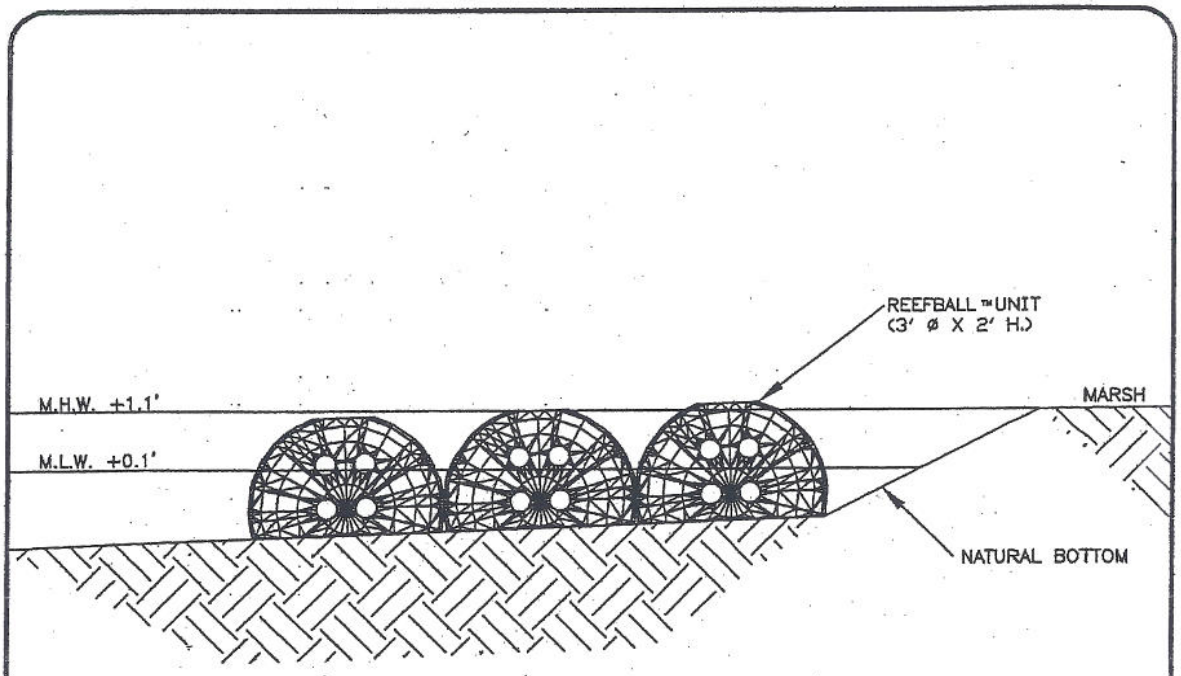
NO.	DATE	REVISION
1	11/27/02	INCORPORATED USFWS AND LDNR/CRD COMMENTS

USFWS AND LDNR/CRD

TYPICAL DETAIL OF A-JACK UNIT
TERREBONNE BAY SHORE PROTECTION DEMONSTRATION PROJECT (TE-45)
TERREBONNE PARISH, LOUISIANA

mph Morris P. Hebert, Inc.
SURVEYING • ENGINEERING • ENVIRONMENTAL SERVICES
P.O. BOX 3106 • HOUMA, LOUISIANA 70361-3106 • (985) 879-2731

DRAWN BY:	TJF	SHEET:	9
CHECKED BY:	RCJ	SCALE:	N.T.S.
APPROVED BY:	DBK	DATE:	7/17/02
MPH CAD FILE:	6818C0E0009A1		



PROFILE
NOT TO SCALE

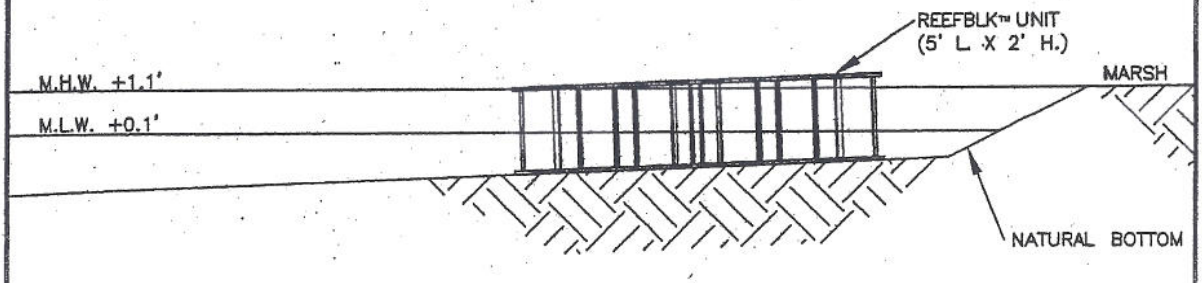
NO.	DATE	REVISION
1	11/27/02	INCORPORATED USFWS AND LDNR/CRD COMMENTS

USFWS AND LDNR/CRD

TYPICAL DETAIL OF REEFBALL UNIT
TERREBONNE BAY SHORE PROTECTION DEMONSTRATION PROJECT (TE-45)
TERREBONNE PARISH, LOUISIANA

mph Morris P. Hebert, Inc.
SURVEYING • ENGINEERING • ENVIRONMENTAL SERVICES
P.O. BOX 3106 • HOUMA, LOUISIANA 70361-3106 • (985) 879-2731

DRAWN BY:	TJF	SHEET:	10
CHECKED BY:	RCJ	SCALE:	N.T.S.
APPROVED BY:	DBK	DATE:	7/17/02
MPH CAD FILE:	6818COE0011A1		



PROFILE
NOT TO SCALE

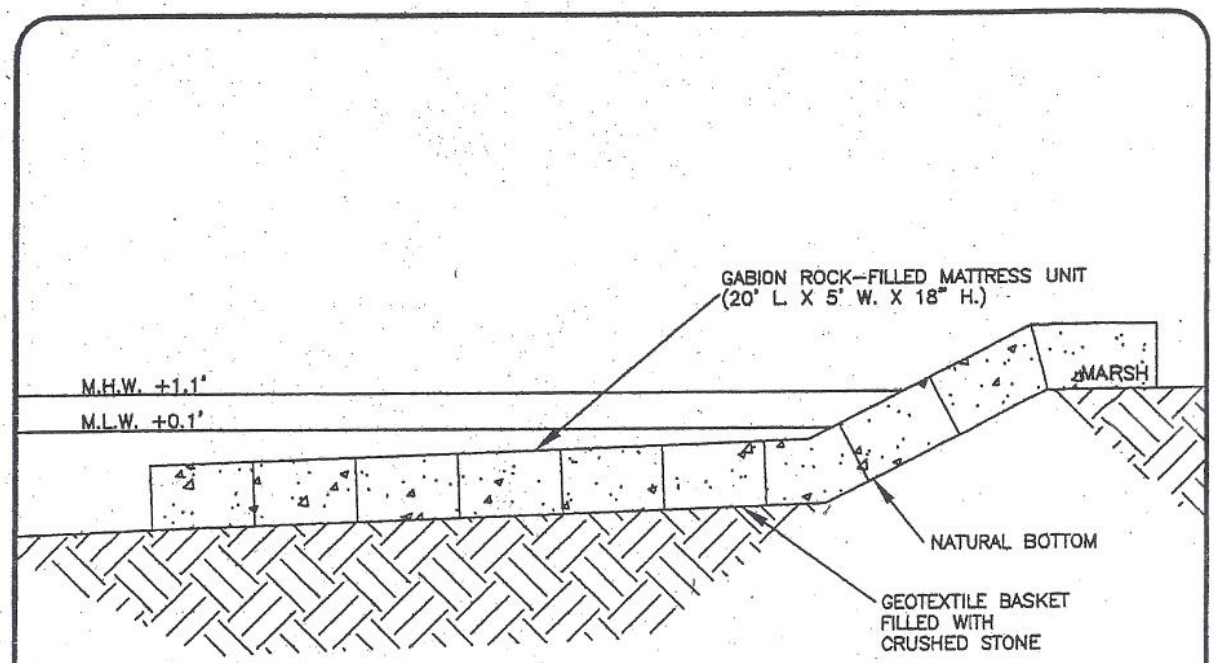
NO.	DATE	REVISION
1	11/27/02	INCORPORATED USFWS AND LDNR/CRD COMMENTS

USFWS AND LDNR/CRD

TYPICAL DETAIL OF REEFBLK UNIT
TERREBONNE BAY SHORE PROTECTION DEMONSTRATION PROJECT (TE-45)
TERREBONNE PARISH, LOUISIANA

mph
Morris P. Hebert, Inc.
SURVEYING • ENGINEERING • ENVIRONMENTAL SERVICES
P.O. BOX 3106 • HOUMA, LOUISIANA 70361-3106 • (985) 879-2731

DRAWN BY:	TJF	SHEET:	11
CHECKED BY:	RCJ	SCALE:	N.T.S.
APPROVED BY:	DBK	DATE:	7/17/02
MPH CAD FILE:	6818C0E0012A1		



PROFILE
NOT TO SCALE

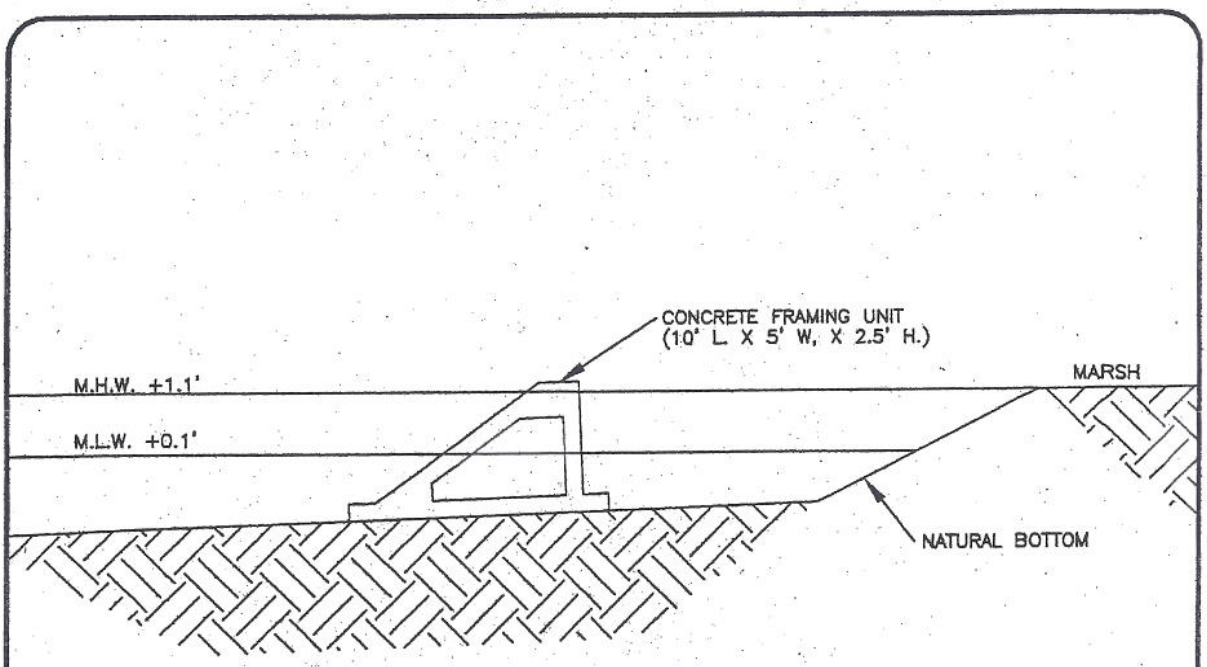
NO.	DATE	REVISION
1	11/27/02	INCORPORATED USFWS AND LDNR/CRD COMMENTS

USFWS AND LDNR/CRD

TYPICAL DETAIL OF GABION ROCK-FILLED MATTRESS UNIT
TERREBONNE BAY SHORE PROTECTION DEMONSTRATION PROJECT (TE-45)
TERREBONNE PARISH, LOUISIANA

mph
Morris P. Hebert, Inc.
SURVEYING • ENGINEERING • ENVIRONMENTAL SERVICES
P.O. BOX 3106 • HOUMA, LOUISIANA 70361-3106 • (985) 879-2731

DRAWN BY:	TJF	SHEET:	13
CHECKED BY:	RCJ	SCALE:	N.T.S.
APPROVED BY:	DBK	DATE:	7/17/02
MPH CAD FILE:	6818C0E0015A1		



PROFILE
NOT TO SCALE

NO.	DATE	REVISION
1	11/27/02	INCORPORATED USFWS AND LDNR/CRD COMMENTS

USFWS AND LDNR/CRD

TYPICAL DETAIL OF CONCRETE FRAME UNIT
TERREBONNE BAY SHORE PROTECTION DEMONSTRATION PROJECT (TE-45)
TERREBONNE PARISH, LOUISIANA

mph Morris P. Hebert, Inc.
SURVEYING • ENGINEERING • ENVIRONMENTAL SERVICES
P.O. BOX 3106 • HOUMA, LOUISIANA 70361-3106 • (985) 879-2731

DRAWN BY:	TJF	SHEET:	12
CHECKED BY:	RCJ	SCALE:	N.T.S.
APPROVED BY:	DBK	DATE:	7/17/02
MPH CAD FILE:	6818COE0014A2		